E-Cloud Simulation With VORPAL (based on talk presented at Compass meeting, Oct 6 2009

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Goals: (I) E-Cloud Sim itself.

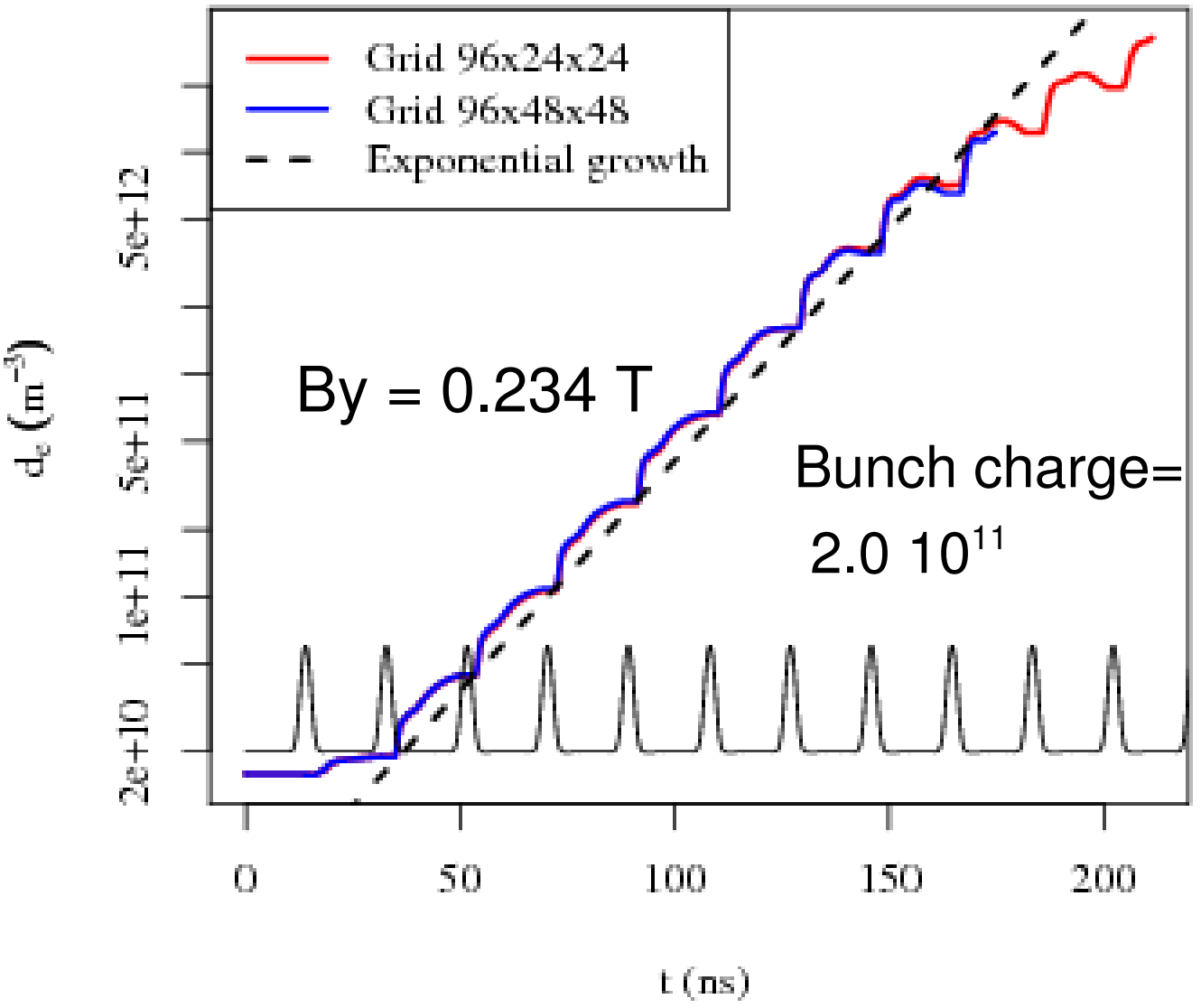
- Study of systematic uncertainty in e-cloud density and induced Electric field at beam location.
  - Varying Usual PIC parameters (grid size, weights,..)
  - Secondary Emission Model parameters.
- Dependency of e-Cloud density on beam current: monotonic or not?
  - Effect of the decrease of the SEY above 300 EeV?
  - Or approximations in the calculation.?

Goals: (II) μ-Wave Experiment

- Amplitude vs frequency modulation: Linear theory predicts no AM. Indirect E-density measurement are difficult to interpret if AM occurs... Up to the experimentalist to show that they don't occur. -> Detailed simulation of the m-wave signal required.
- Simulation of the 14 m. long “old” (FY09) setup at MI, then, if applicable, the new 2 m. long “short, B=0.” at MI currently in operation...
- Extra-credit: role of ions, hybrid resonances?

Example of systematic uncertainties studies

- E-Cloud induced Electric field at ~3 sigma from the beam, vs grid spacing.. w/o static magnetic field.
- Steps in the calculations:
  - Remove m-wave, for sake of simplicty
  - Short beam pipe, to speed things up (but not too short, to avoid leakage on the side.
  - Weighted Monte-Carlo (not yet there..)

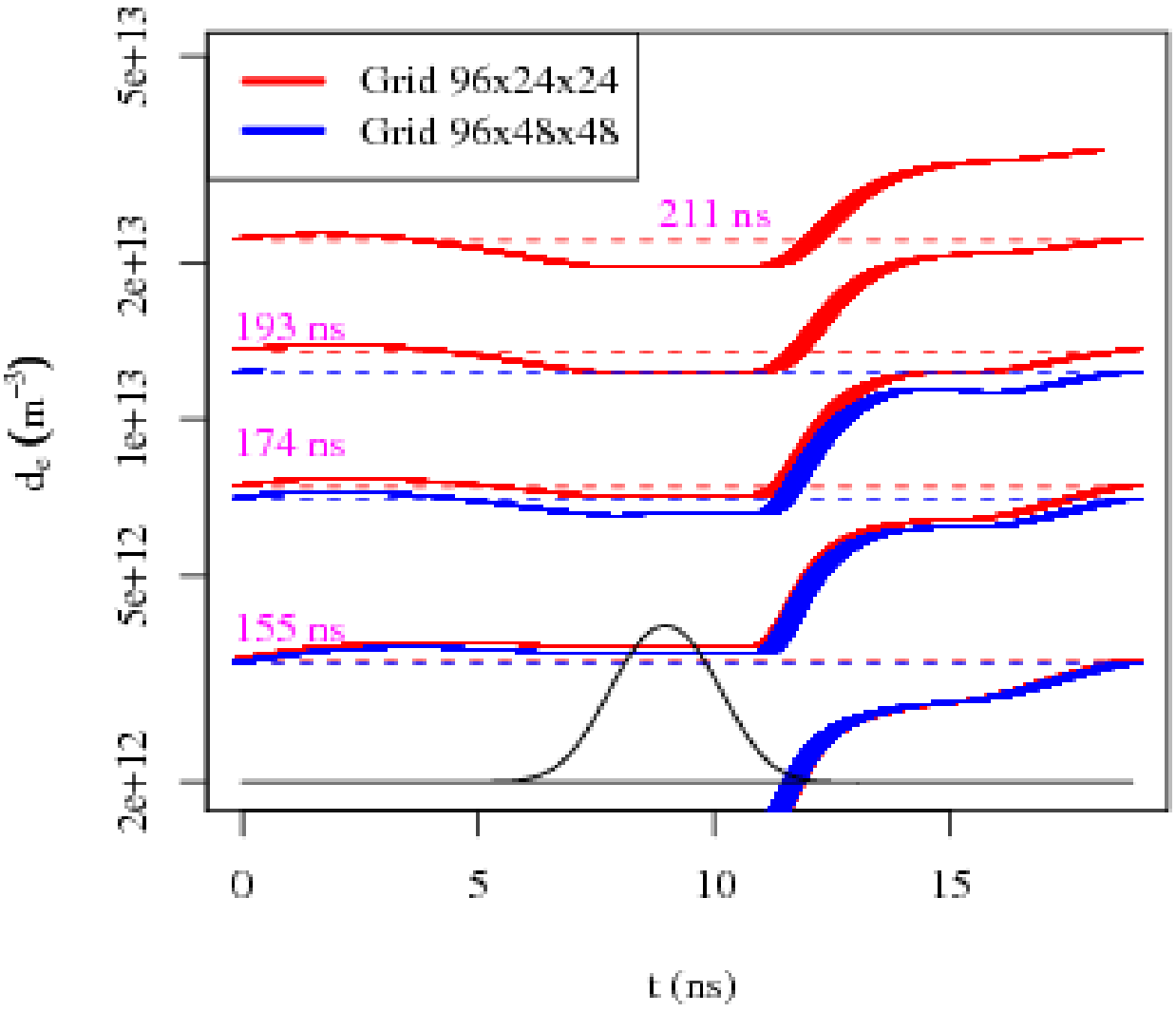


Simulation of the of the e-cloud growth:

- cell size ~ 1 mm
- Length: 25 cm.
- time step: 3 to 5 ps.

Result:

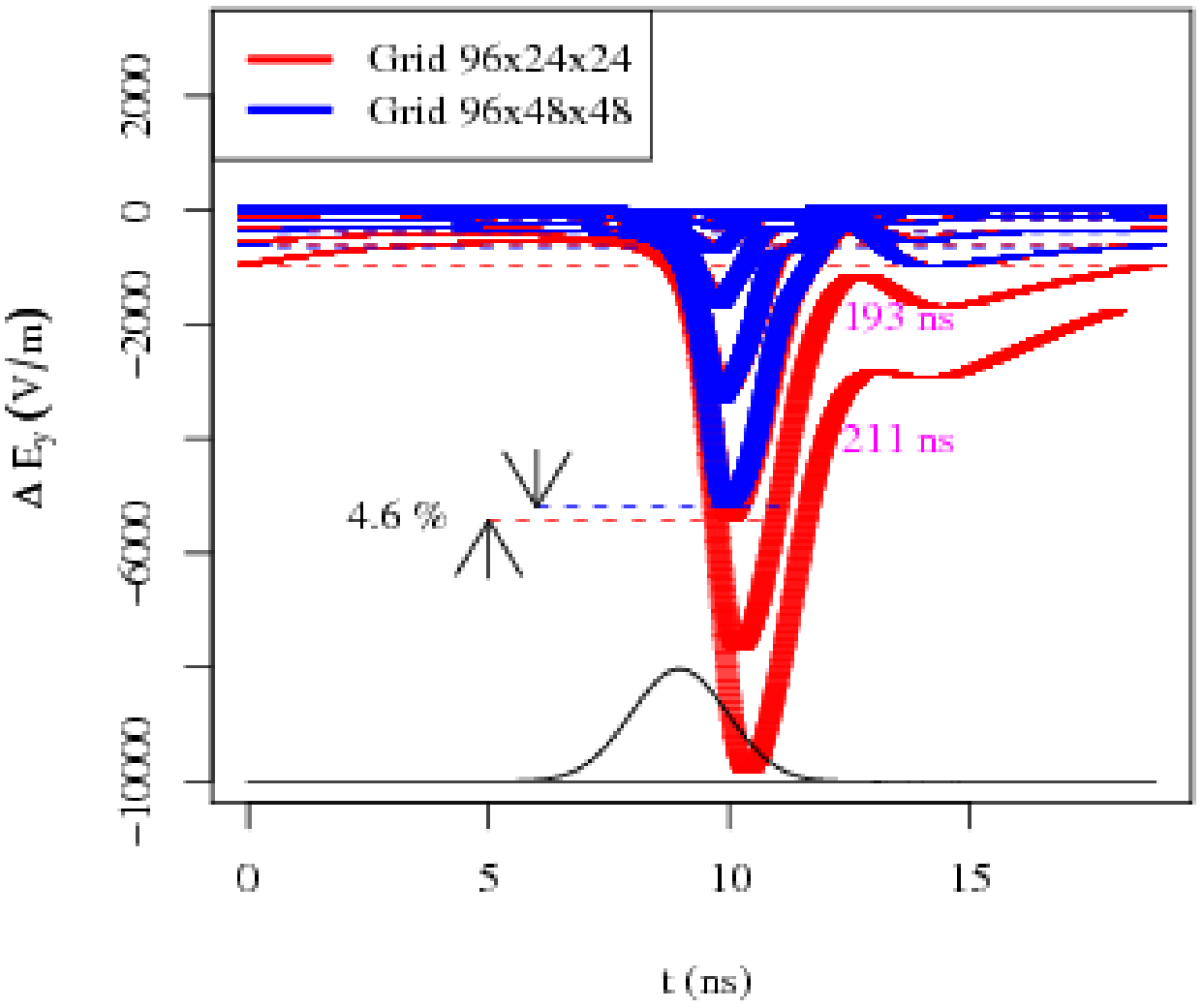
- Clear indication of saturation, without electron culling, or “dark surface”.



... Modulo beam freq.

Result:

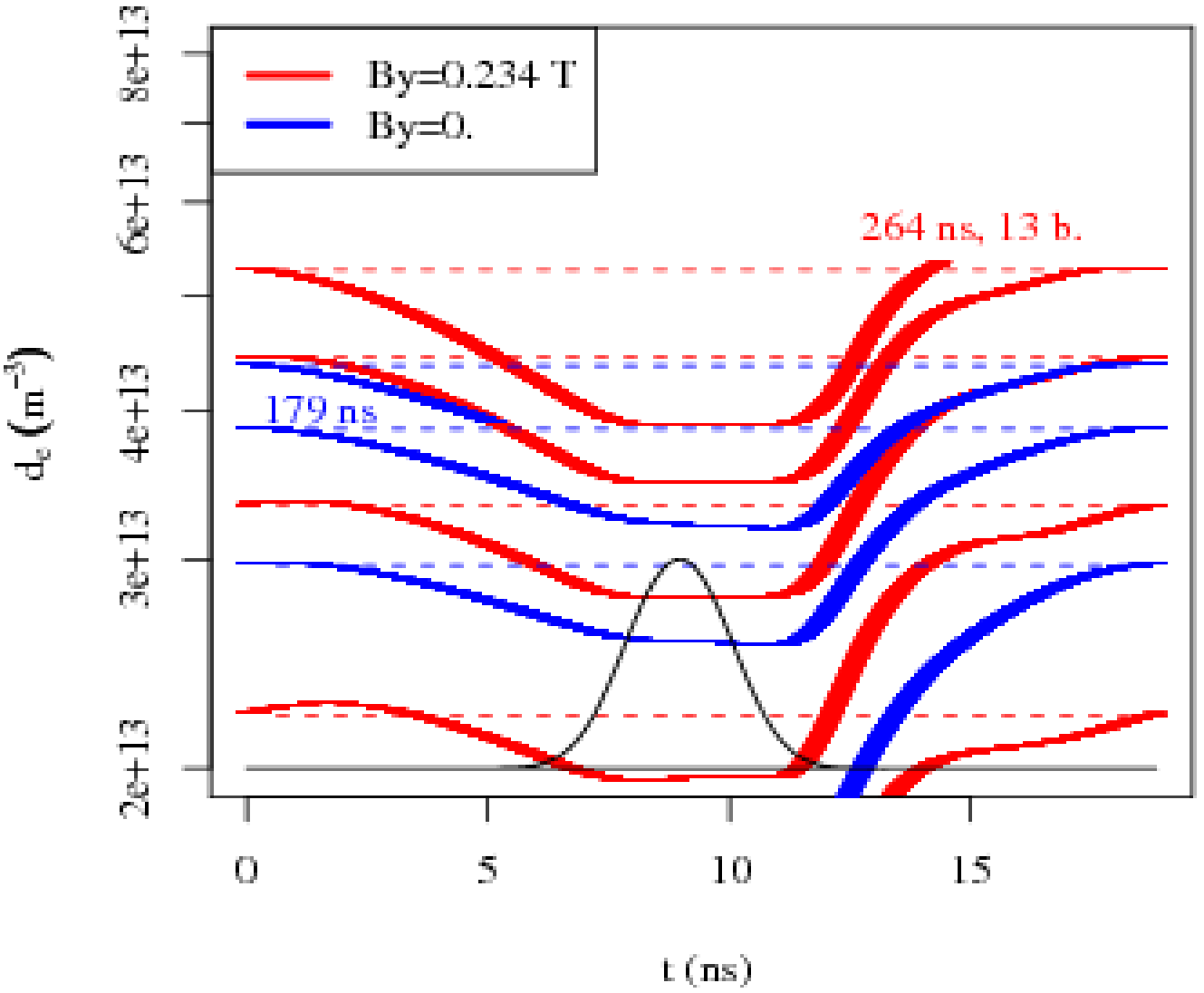
- Clear indication of saturation, without electron culling, or “dark surface”.
- At ~ 5 10^{13} e/m^{-3}, linear density of e-Cloud ~ bunch, after 10 to 15 bunches.



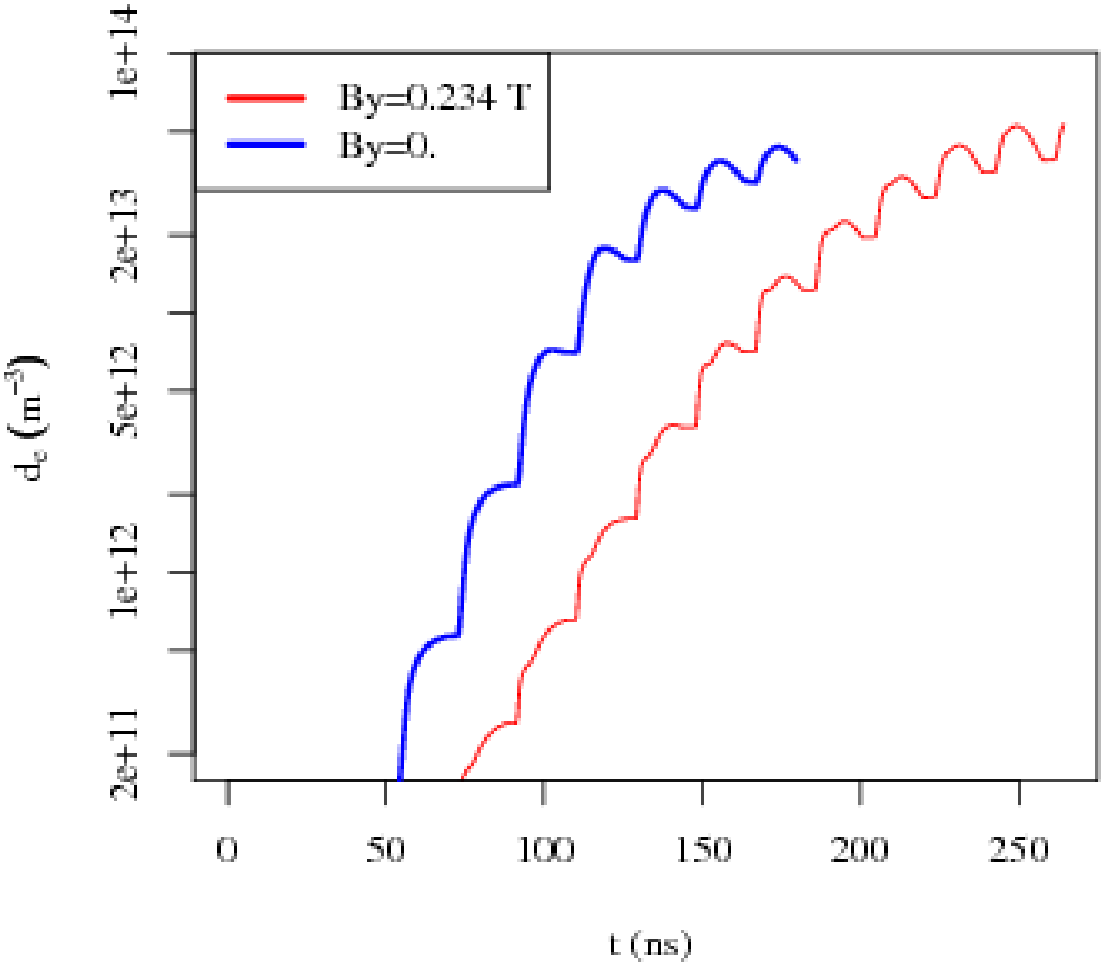
... What counts for beam physics:

Electric field induced by the e-Cloud Obtained by subtracting w/o seed electrons

At 1 cm above from center of beam (or beam pipe)



Close to 100% saturation of linear charge...

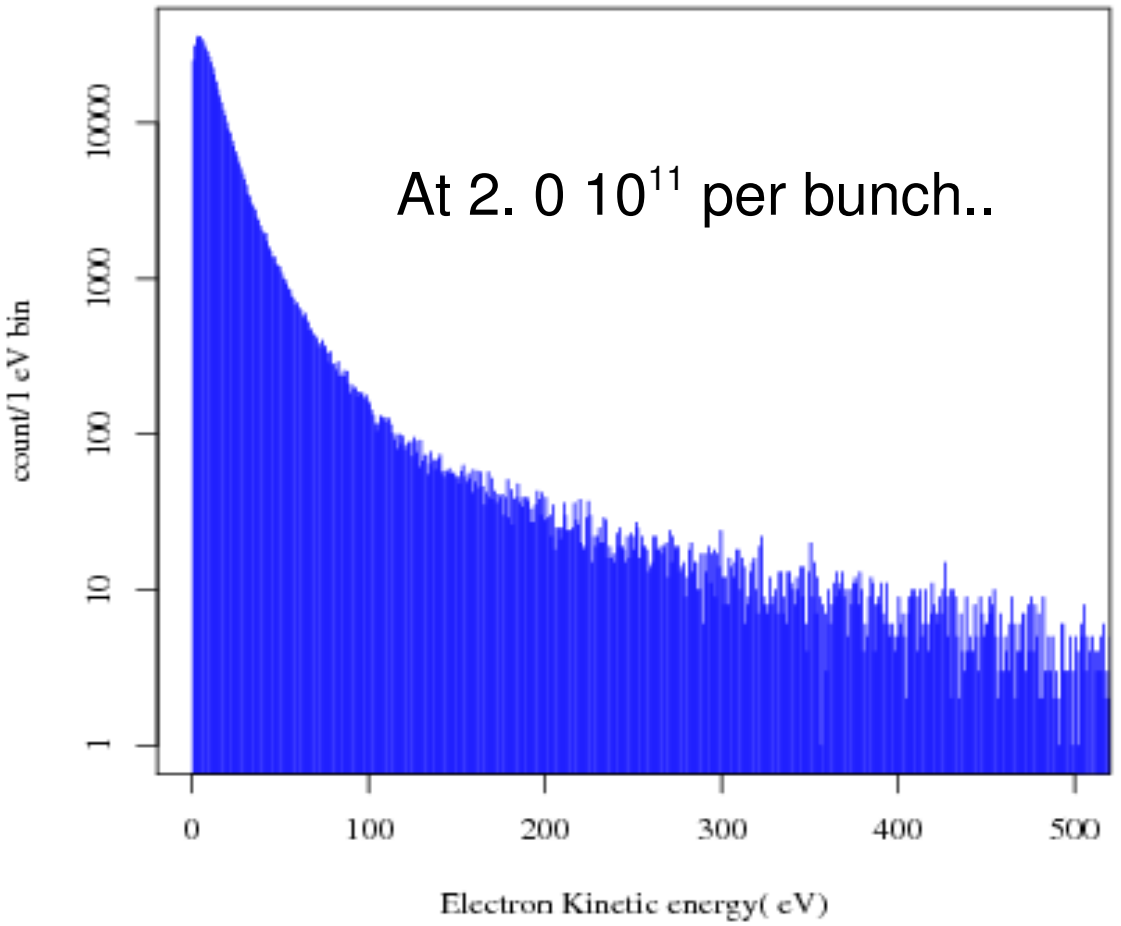


Running a bit longer..

Saturation clearly seen after ~ 13 bunches...

Slower with a magnetic field (as expected..)

Energy Spectrum:



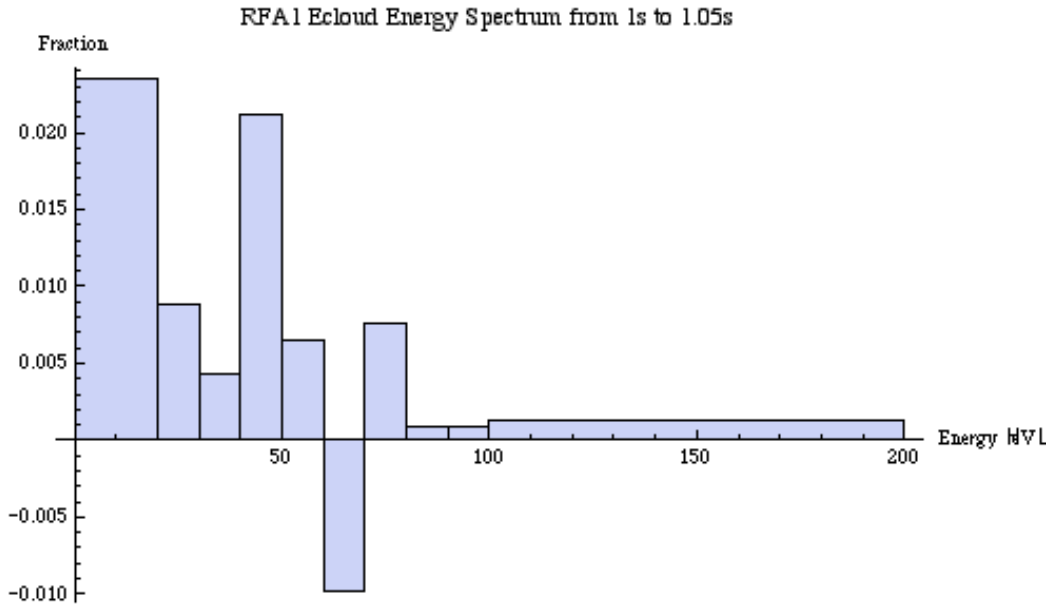
Recorded after
a few bunches crossing.

Might not be the steady
during the train, but close...

Dominated by low energy..

From Tan's talk, Sept 24 2009...

Energy Spectrum



RFA2,3 amplified.

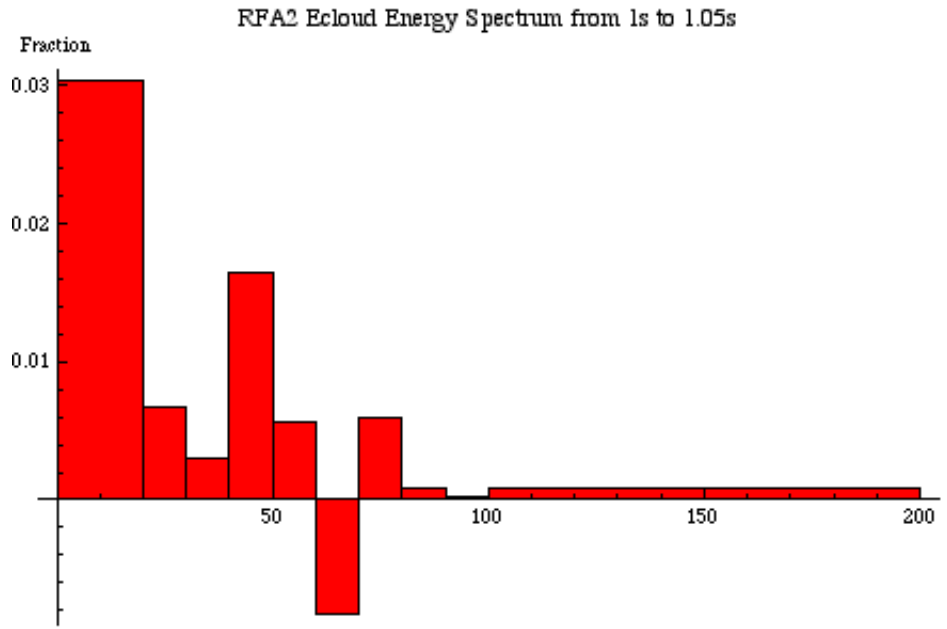
Ignore 0-20eV?

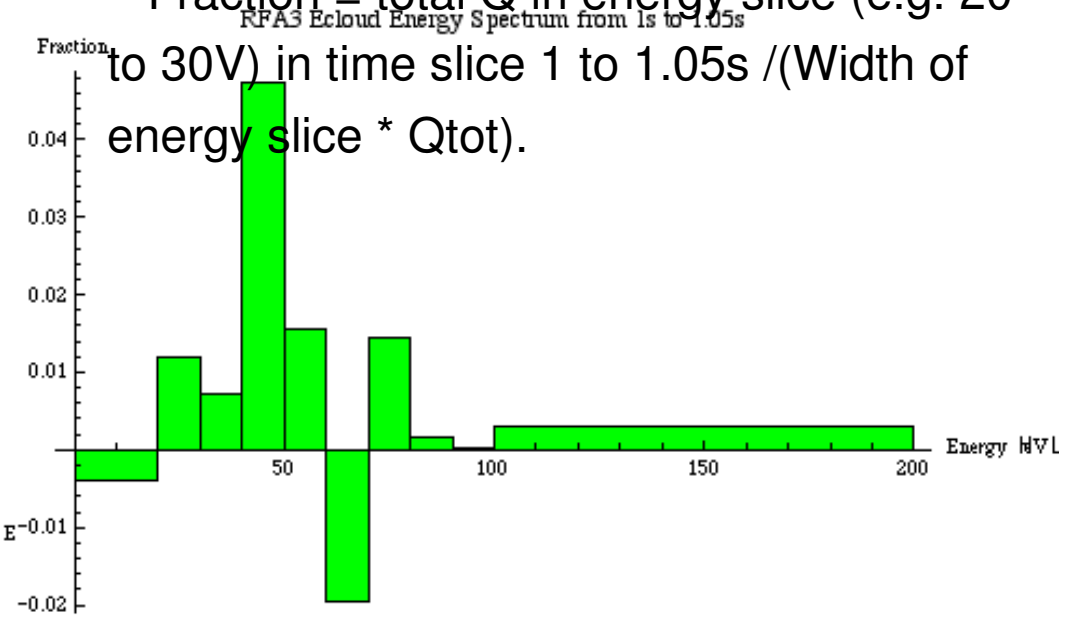
Max energy around 40-50eV.

Definition of fraction:

Qtot = all the charge in the time slice 1 to 1.05 s at "0" volts

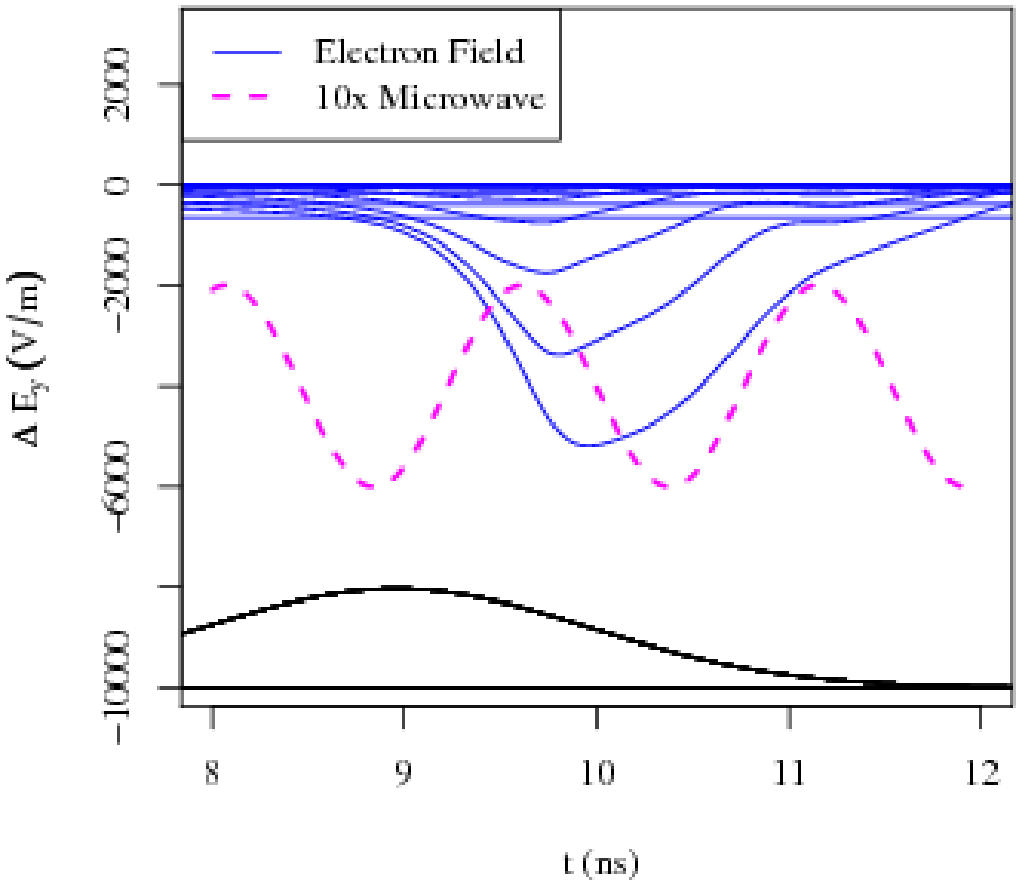
Fraction = total Q in energy slice (e.g. 20 to 30V) in time slice 1 to 1.05s /(Width of energy slice * Qtot).





μ-Wave: Amplitude Modulation?

Nathan E. : "No A.M. Modulation seen over the 14 m. long"



Same composite plots as previous,with the 1.5 GHz

e-could induced field ~10 time higher, same ν range. => AM !

But appears at 53.1 MHz !...

AM: Simulation issues.

- Integrating away the 53.1 MHz. “Averaging over many, many bunches” ? Brute force: with the existing VORPA script, no can do.. Clever algorithm? Repeat bunches? Accuracy!???
- Quasi dipole blip seen in previous slide: does not couple to the BPM at 1.5 GHz.. Unseen..
-

Plans: Physics issues

- Many parameters to scan -> tedious..
- Most Critical source of uncertainties comes from Secondary emission model!..
- M-wave: simulation of cancelation of signals at 53.1 MHz via integration over many bunches, => not feasible right now.. need ~100 times more CPU power of other idea..

Plans: Required VORPAL upgrades.

- Access to Secondary Emission model parameters
- Ability to cull the electron cloud. Simple, light CPU load algorithm preferred. (strictly random cull!)
- Port to Intrepid. (or, just use multipole for a few month (year/)

How can I help???